Chapter 5

FORECASTS OF FUTURE ACTIVITY AND FLOWS

In this chapter we will examine the forecasts of highway and railway flows for the target years of 2005 and 2015. We will begin with the logic behind this portion of the study and the basis for the traffic forecasts.

Background

In the previous chapter the highway and rail flows were distributed using a fully constrained gravity model. The program used in that portion of the study also yields values for all of the parameters necessary to calculate the model's outputs. These include the normalizing factors of the model, i.e., the *A* and *B* parameters of the model. In addition the model generated also has a beta value, which is the weight put on the measure of spatial separation used. It should be apparent that if we assume these parameters are constant into the future, then it would be possible to distribute "future" traffic flows. In order to do this we would only need estimates of future commodity traffic productions and attractions. These would then be placed in the calibrated 1993 gravity model and estimates of future traffic (estimates of flow between origins and destinations) would result.

Forecasts of future transportation flows begin with a calibrated gravity model for the flows of interest, as noted above. We next need forecasts of the traffic generation elements. This can be accomplished by forecasting values for the independent variables that went into the production and attraction equations of the last chapter; this was the approach taken during the phase 1 study when no current data were available [1]. In that earlier case these equations were derived using data for 1977. The calibrated models were run with input variable data from the 1989 *County Business Patterns* [2].

An alternative would be to use data from a long term series for employment and population and project these into the future. Such data would also be available from the *County Business Patterns* and the *Census of Population* [3].

Alternatively, one could use forecasts of variables related to the traffic generation variables

and use these as the basis for estimating growth factors for traffic production and attraction. For example, we could use forecasts of future population and manufacturing for Indiana counties and other states and assume that the growth in the sectors of interest here would be reflected by the expected growth in these variables. This is the exact approach used here for most of the manufacturing sectors examined. A variation on this approach was used for farm products, coal, non-metallic minerals, and waste. The mail and express mail sectors were derived as a function of population and this was used in their forecasts.

Forecasts Used for Traffic Generation

At the beginning of this project it was agreed that the flows analyzed would be forecasted for two points in the future: 2005 and 2015. It was also agreed that the basis for these forecasts would be projections developed by *Woods and Poole* [4]. Below we will examine the methods used to forecast future flows of the manufactured goods. These methods are very uniform since employment is a fairly good indicator of productivity and population is a reasonable indicator of demand for products. Resource based goods are a little more difficult to handle since the resources are not ubiquitous or uniformly distributed, e.g., coal is mined where coal deposits exist. As a result it is a little more difficult to forecast these flows. The final flow discussed below is waste; it shares some of the characteristics of manufactured goods as we will see.

Manufactured Goods

As noted above, the source of the forecasts of population and manufacturing activity is *Woods and Poole*. The forecasts available were for the counties of Indiana and the nation as a whole. Ordinarily, one would shy away from external forecasts of this nature. However, the population forecasts include the traditional attributes of cohort survival methods as well as expected economic activity, realizing that economic conditions influence the growth or loss of population. The county level manufacturing employment forecasts appear weak until one recognizes that the forecasts are essentially forecasts of what is there currently. In other words the forecasts of manufacturing employment take into consideration whether the local manufacturing industries are growing slowly or rapidly when the forecasts are made. High manufacturing forecasts would result from high growth industries, while little or no growth in this employment would be expected for counties with sluggish or no-growth industries. This attribute strengthens the forecasts considerably.

As noted the *Woods and Poole* data include county and national level forecasts for population and manufacturing employment. In general the population growth forecasts are the high set of forecasts, while the forecasts of employment in manufacturing tend to be lower. For Indiana the predicted growth in population will have this sector growing 7.64% between 1993 and 2005, and 7.41% between 2005 and 2015. Manufacturing employment is expected to grow 6.39% during the 1993-2005 period and 4.09% during the 2005-2015 period. It is also possible

to assume that the growth rate of each sector will be influential; an average of the two growth rates may be considered important. This would yield growth rates of 7.02% for the first time period and 5.75% for the second time period. In effect, three ranges of flow production and attraction forecasts were derived: using population yields the highest growth rate, using manufacturing employment yields the lowest growth rate, and an average of the two yields a "middle" or most likely rate. Of course this is only an example using state level statistics and forecasts. The actual "multipliers" are derived from forecasts for each county's population and employment growth in Indiana and incorporate attributes of each county's economy.

The forecasts available to the project did not include forecasts for the other states. They do include national forecasts and the assumption was made that each of the other states had the same expected growth as the nation as a whole. This is a weak assumption, without argument, however the primary concerns here are the transport of farm products, minerals, and manufactured goods whose traffic is produced and/or attracted by Indiana counties. The use of national growth forecasts provides a foundation for the state forecasts and should not necessarily undermine the Indiana county forecasts. In addition, the sum of the expected growth throughout the states will be equal to the national total used here. The only possible source of error might be one region of the country growing at a different rate than the nation as a whole, and there are numerous reasons for believing that these regional variations in growth rates will cancel each other out over the forecasting period used here (1993-2015).

The county-level traffic production of manufactured goods for each of the fifteen commodity groups examined here was allocated using the expected average growth in population and manufacturing employment in the county as discussed above. This average value was used simply as the growth factor for 2005 and 2015. For example, assume a county produced traffic of 100 units of a commodity in 1993. The expected average growth in population and manufacturing for that county might be 7% between 1993 and 2005 and 4% between 2005 and 2015. Using these two growth factors would yield productions of 107 units for 2005 and a little more than 111 units for 2015. It has long been recognized that manufacturing employment is a good indicator of commodity production and this latter variable is a key determinant of the amount of a manufactured good available for shipment [5]. The use of population as well reinforces and stabilizes the forecasts. Therefore, this seems like a reasonable approach.

Manufacturing traffic attraction is similar to traffic production. This traffic is attracted to both the personal consumer market as well as industrial markets. In effect, as the population and manufacturing employment grow there is an increase in traffic attracted. There is not sufficient information to weight these factors differentially on the basis of their importance in each county. Therefore, manufacturing traffic attraction is assumed to be equal to the expected average growth of population and manufacturing employment here also. If an area has no growth industries it may still attract traffic based on growth in its personal consumer market. Similarly, areas of stable population levels may still attract traffic if it has dynamic industries that use other products

in their own manufacturing processes.

Resource Based Commodities

Farm products include a broad array of goods that are tied to soil quality. They include apples from the orchards of Washington state, cattle from Texas, corn from Indiana, and so forth. In some cases production is tied to economic conditions, in other cases to weather conditions. We don't forecast either of these very well. Increasing agricultural mechanization has resulted in employment being a poor indicator of production potential in this sector. After analyzing the different variables available a decision was made to use farm earnings (from *Woods and Poole)* as an indicator of future flow production for farm products. For consumption or traffic attraction in this personal consumption sector, population growth has been used.

Forecasting the flow or production of coal is difficult at best. What is it related to? We might think that demand for coal is a function of economic conditions, and that is true. But there are numerous other factors that influence this variable. If the U.S. had not moved toward improving air quality, we would not see low sulfur Rocky Mountain coal transported to the Midwest. The Clean Air Act changed the overall distribution of coal in this country. If the federal government moves to significantly curtail carbon emissions in response to the recognition that global warming had begun, it might remove high sulfur coal regions from production. That possibility has not been factored in to the projections, and this may indicate the tenuous nature of the forecasting coal flows.

The variable selected as a growth factor for coal production is total earnings from mining as forecasted by *Woods and Poole*. Attractions would seem to be more closely related to consumers of coal, but our analysis did not support this belief. In effect, coal tends to be attracted to areas of coal production. This seems nonsensical until we remember that low sulfur coal is shipped to high sulfur coal states for mixing and reducing the overall sulfur content per unit of weight. As a result attraction of coal was also forecasted based on the forecast for total earnings from mining.

Non-metallic minerals flow production was also be related to total earnings from mining so this variable was used here as well. Recall that these minerals tend to be shipped very short distances since they are often rather ubiquitous and low in value. It stands to reason that a variable that correlated with production should also correlate with attraction. So total earnings from mining was used to forecast attractions as well.

Waste and Scrap

We might think of waste and scrap as being very much related to population and economic levels. This image is probably correct in the case of garbage, but this category is more like

industrial waste and scrap that can better be treated by other firms in the case of waste, or better used as inputs to manufacturing, e.g., scrap aluminum or steel are attractive inputs for manufacturing these metal products. As a result we have taken the growth of employment in manufacturing as an indicator of the expected growth in the production and attraction of waste and scrap.

Flow Forecasts

Each of the 145 geographic units in this study had their traffic productions and attractions estimated as described above for each of the 15 manufactured commodity groups, for the four resource oriented products, and waste and scrap for each of the target years (2005 and 2015). Mail and express mail were not discussed above since they were developed as a function of population. Therefore growth in population was used to forecast growth in these flow productions and attractions. The resulting values from all of these efforts were inserted in the gravity model in place of the production and attraction values of 1993. As noted above, it is assumed that the parameters of the model and the beta value would remain constant into the future. In effect, the forecasts of future flows are accomplished using models of current flows with forecasted inputs.

For the 2005 and 2015 forecasted flows, the average shipping distance nationally or for Indiana may be more or less than it was at the time of the base study (1993), i.e., there are no constraints placed on these "commodity specific" values. This is as it should be.

Given the distributed flow forecasts the next question is how should these flows be split between specific modes of transport and then how would these flows be assigned to the transport networks of interest. For the modal split analysis use is made of NEWMODE, the computer program that examines the length of shipment and the commodity to determine the modes to which the forecasted flow should be assigned. Following this assignment, one must assign the traffic to specific links of the networks identified. At this point one would make use of the same traffic assignment technique used during the allocation of the 1993 traffic to the network. This is exactly what has been done here and the cartographic results for road and rail for both target years appear in this chapter. Included are maps for six types of flows: manufactured goods, farm products, coal, primary metal products, petroleum and coal products, and total flows. Maps have been prepared for both rail and highway flows, for both target dates of 2005 and 2015, resulting in 24 maps that appear in this chapter (Figures 5.1 through 5.24).

Examination of the forecasted assigned flows indicates that by and large there is exceptional stability in the maps. This is in part misleading because the assigned flows tend to follow the same routes in the future and the traffic increases observed are often not that large. When the increases are significant the band-width adjusts to this as well.

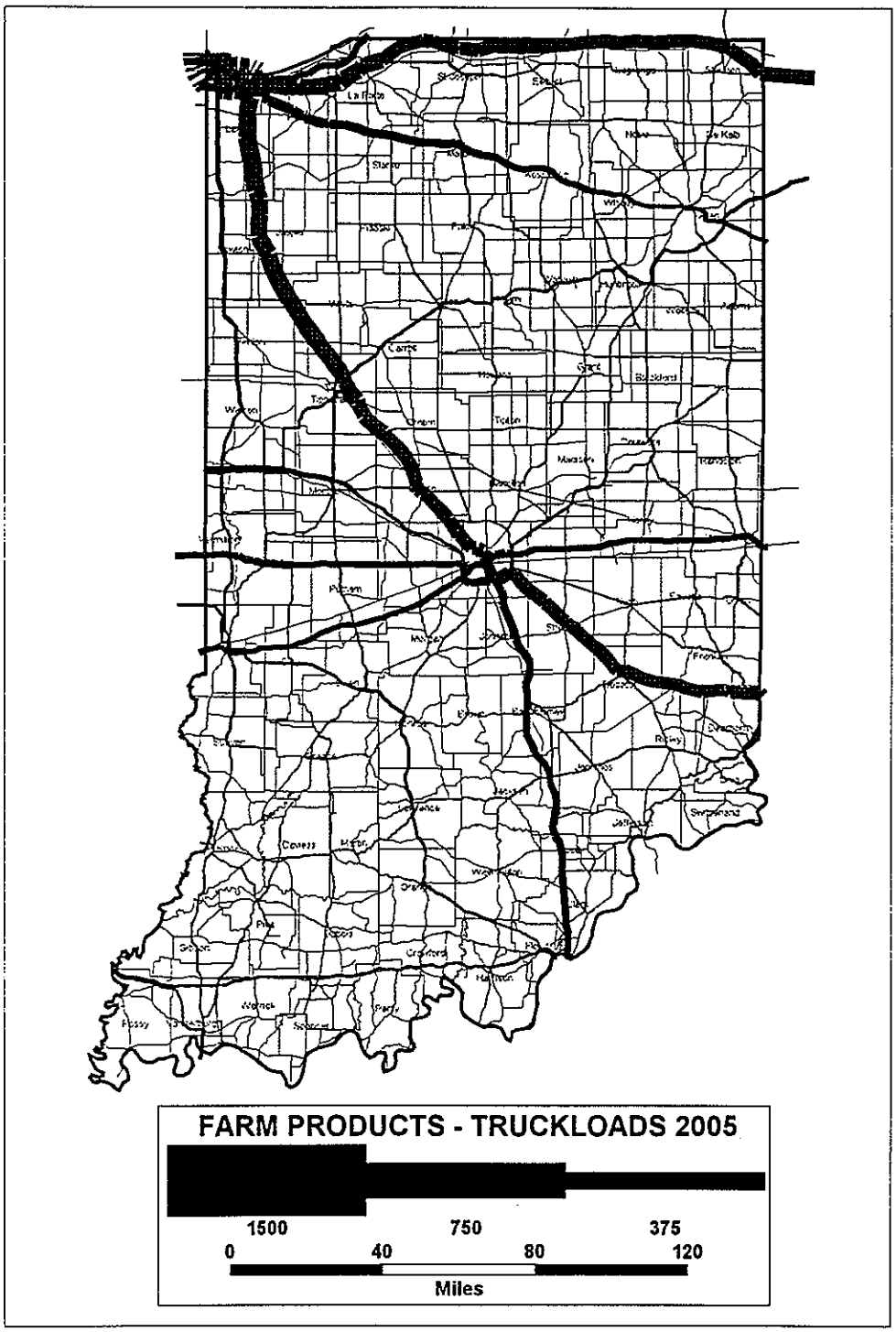

Figure 5.1 Daily Motor Carrier Volumes - Farm Products 2005 Forecast

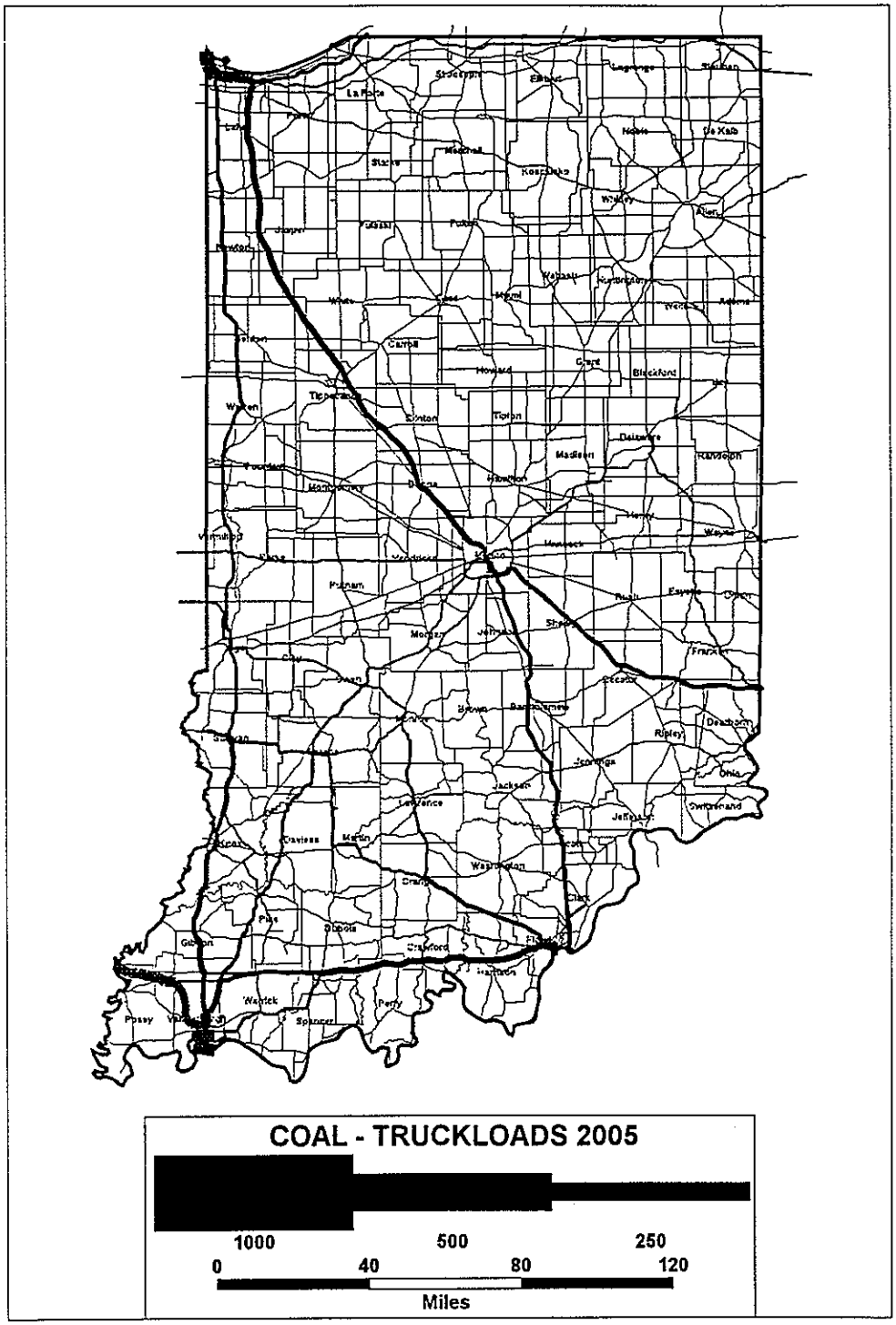

Figure 5.2 Daily Motor Carrier Volumes - Coal 2005 Forecast

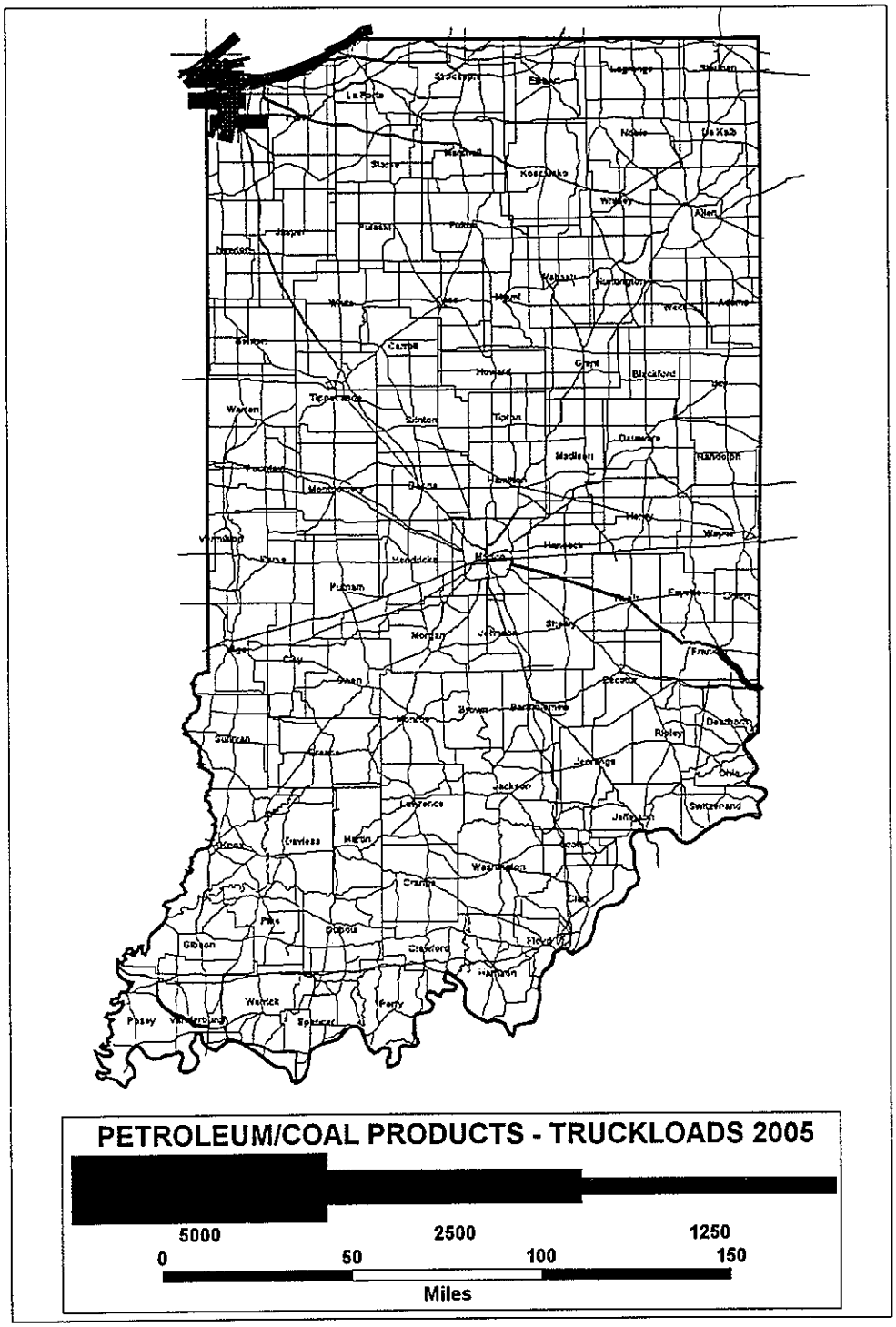

Figure 5.3 Daily Motor Carrier Volumes - Petroleum and Coal Products 2005 Forecast

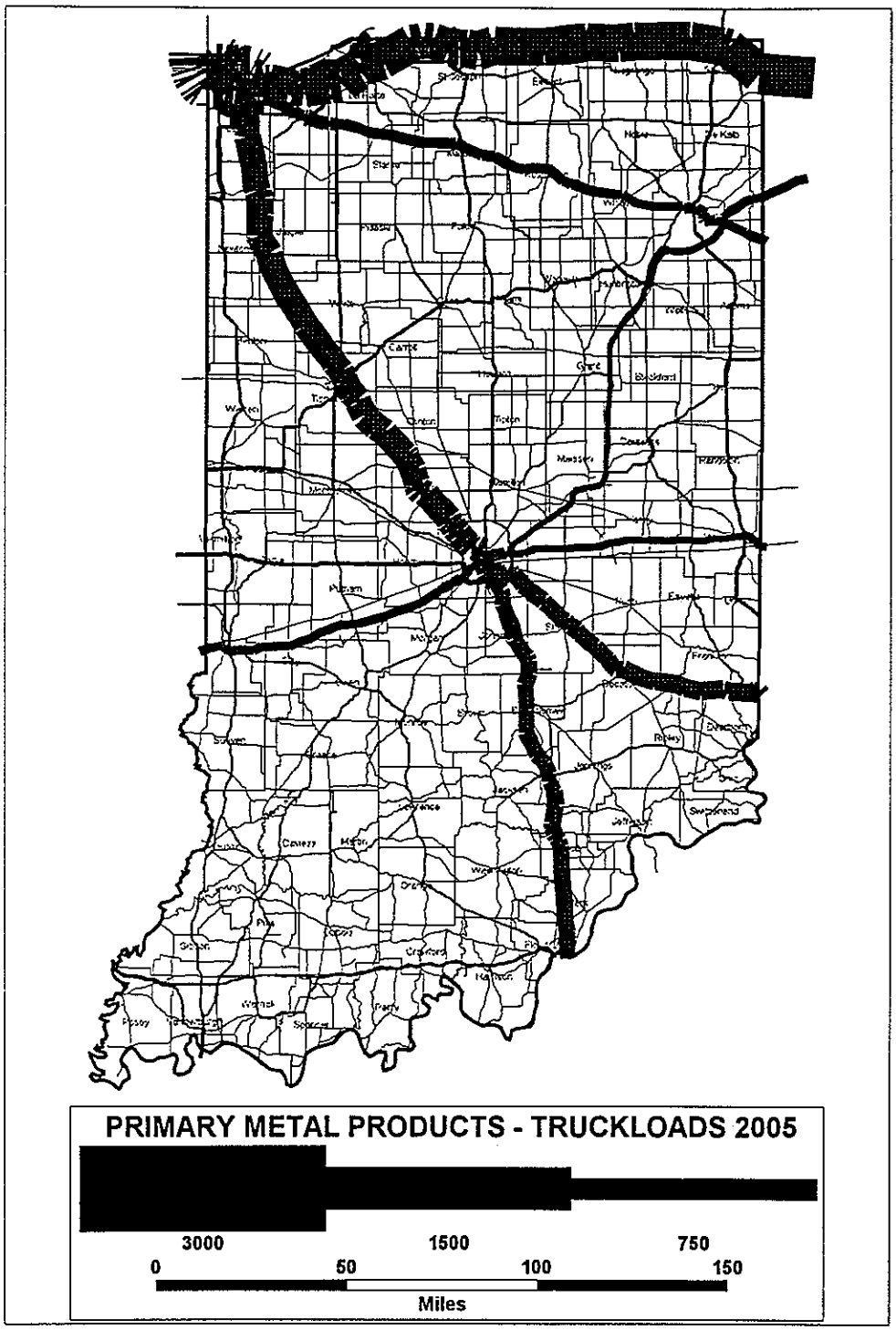

Figure 5.4 Daily Motor Carrier Volumes - Primary Metal Products 2005 Forecast

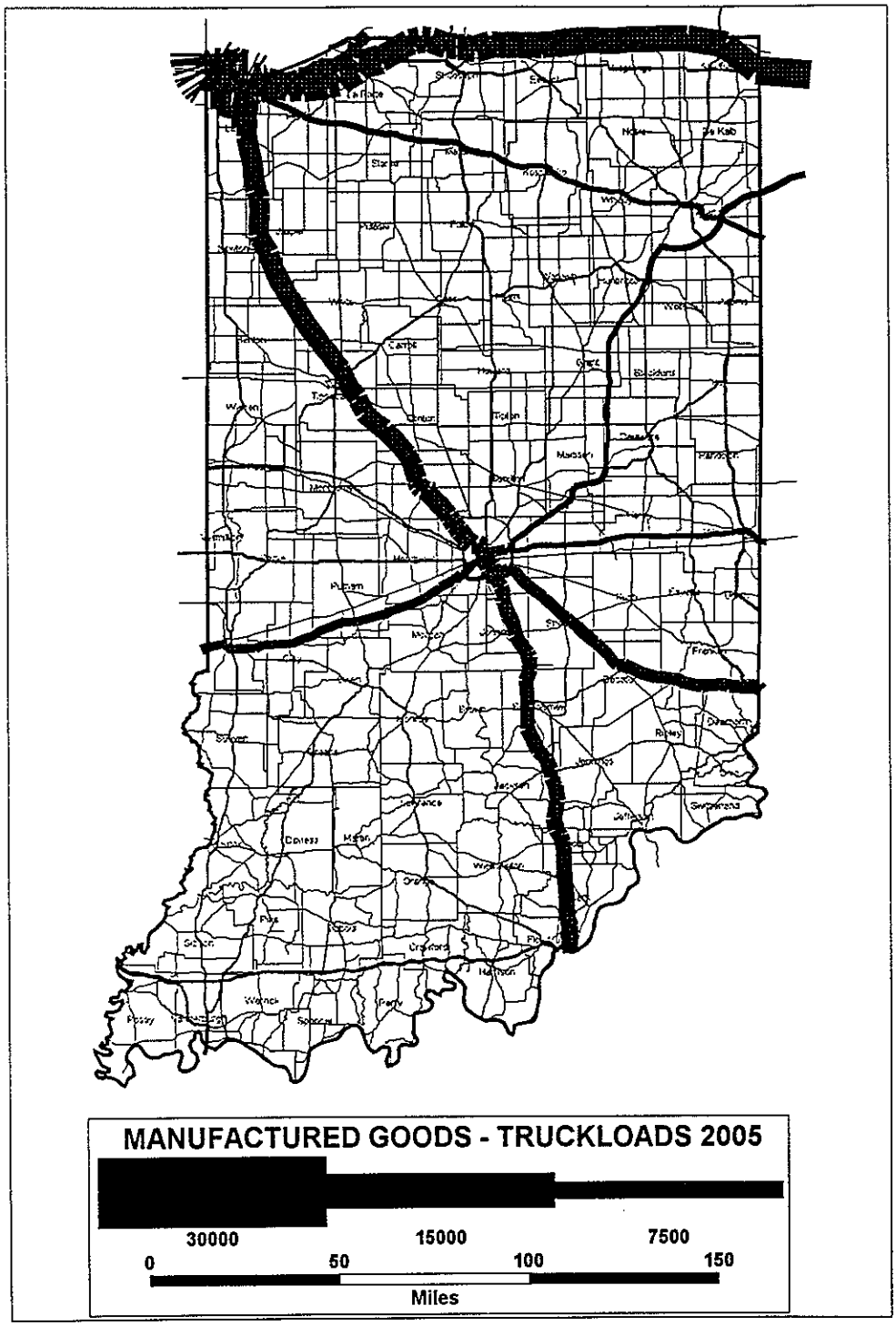

Figure 5.5 Daily Motor Carrier Volumes - Manufactured Goods 2005 Forecast

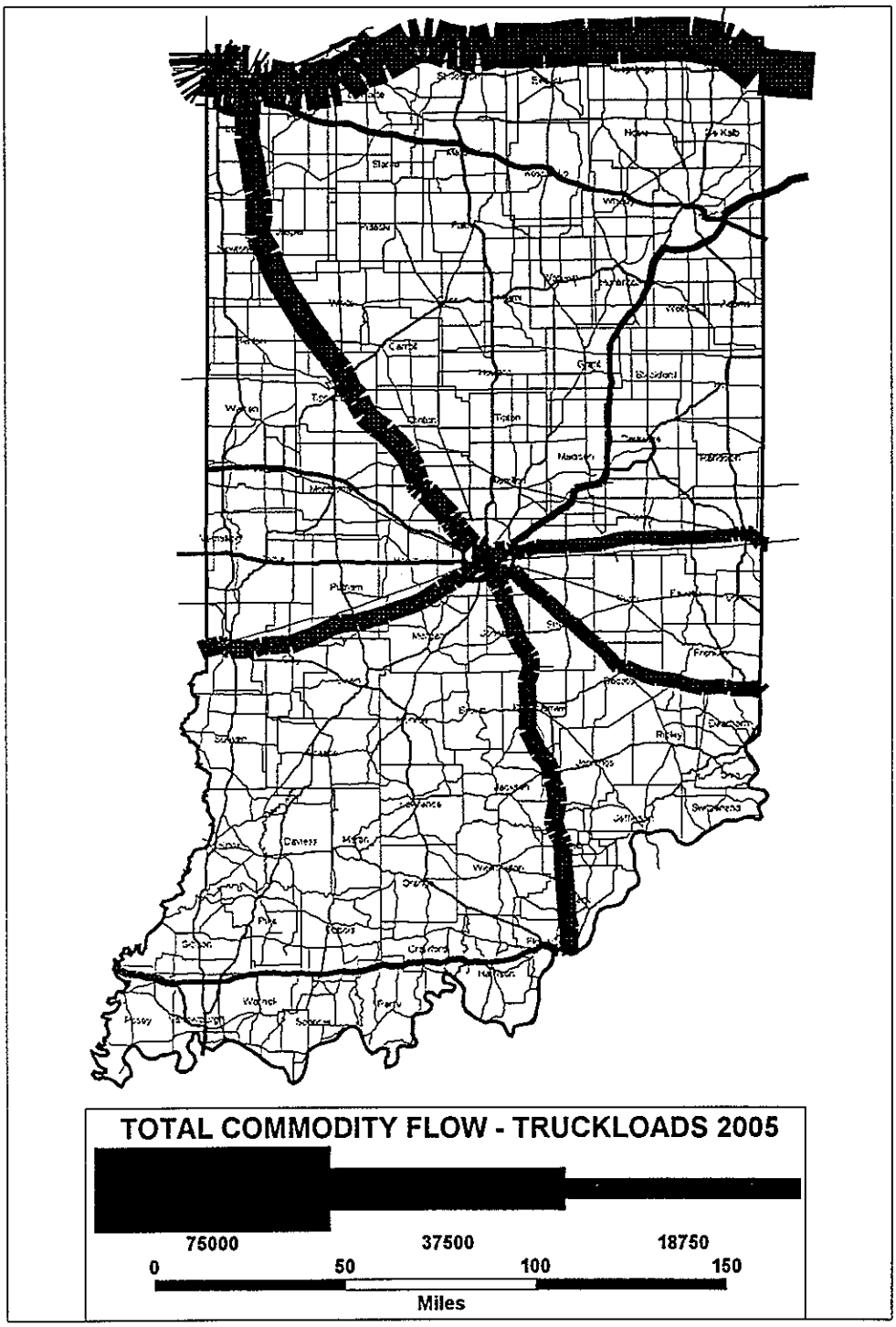

Figure 5.6 Daily Motor Carrier Volumes - Total Traffic 2005 Forecast

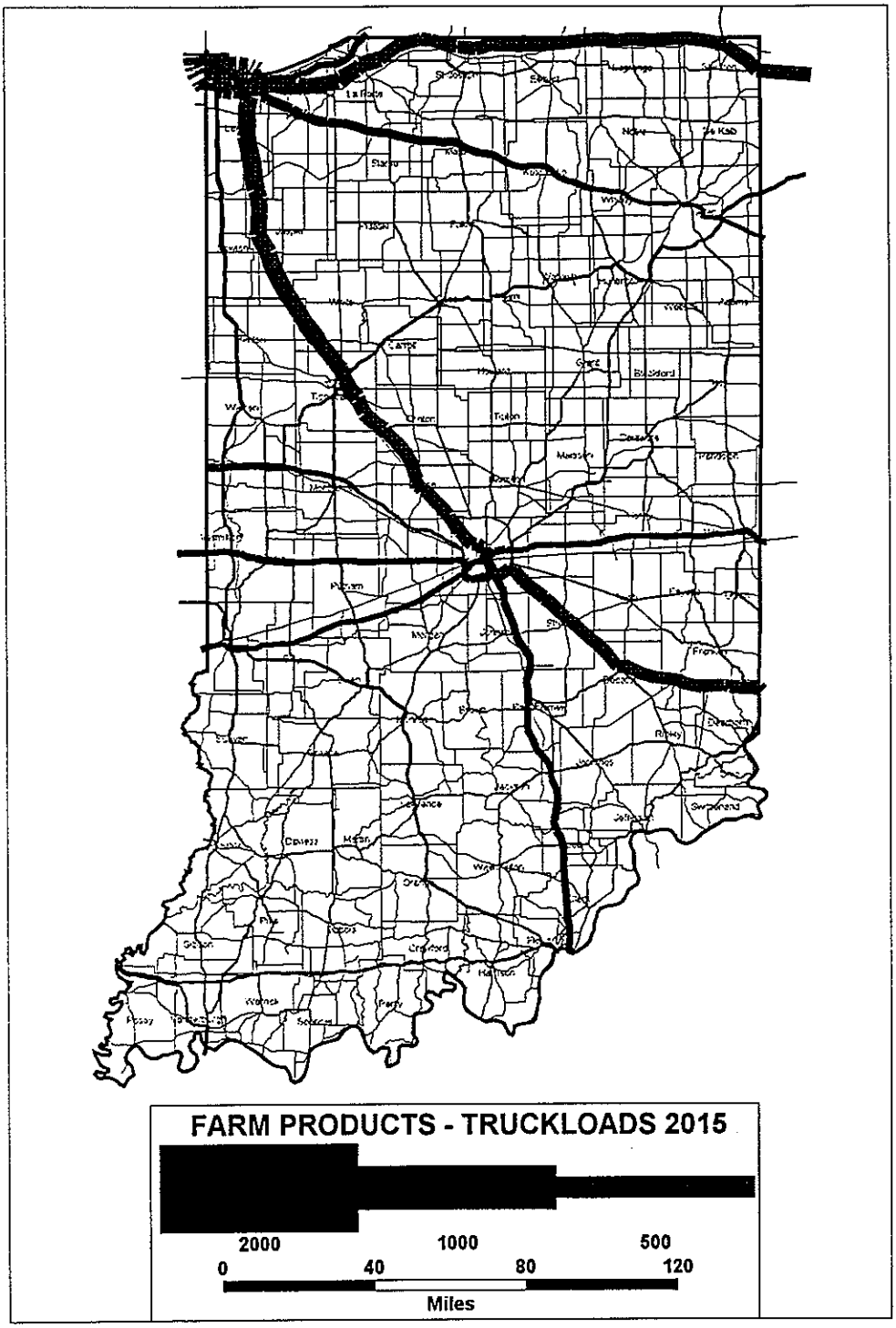

Figure 5.7 Daily Motor Carrier Volumes - Farm Products 2015 Forecast

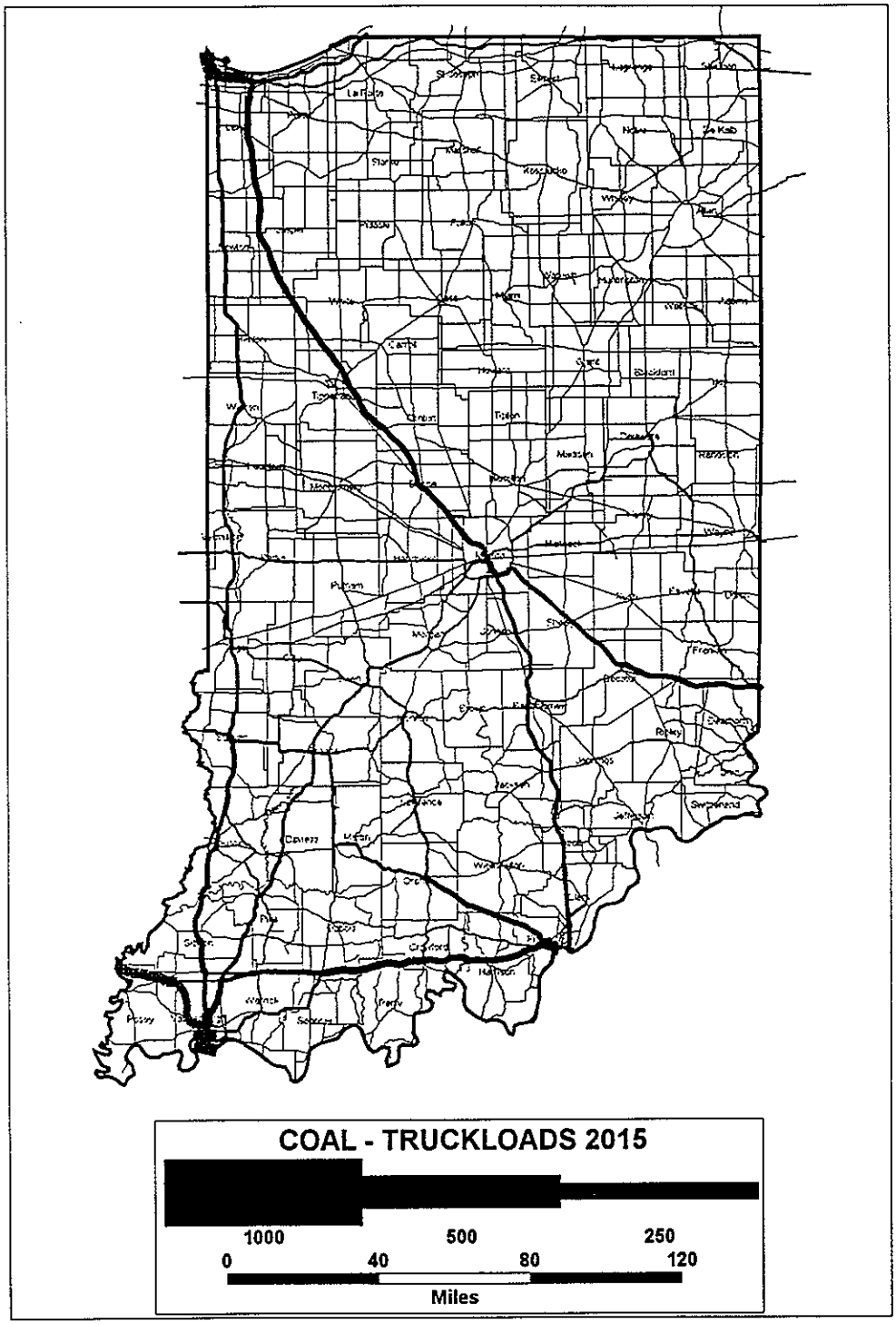

Figure 5.8 Daily Motor Carrier Volumes - Coal 2015 Forecast

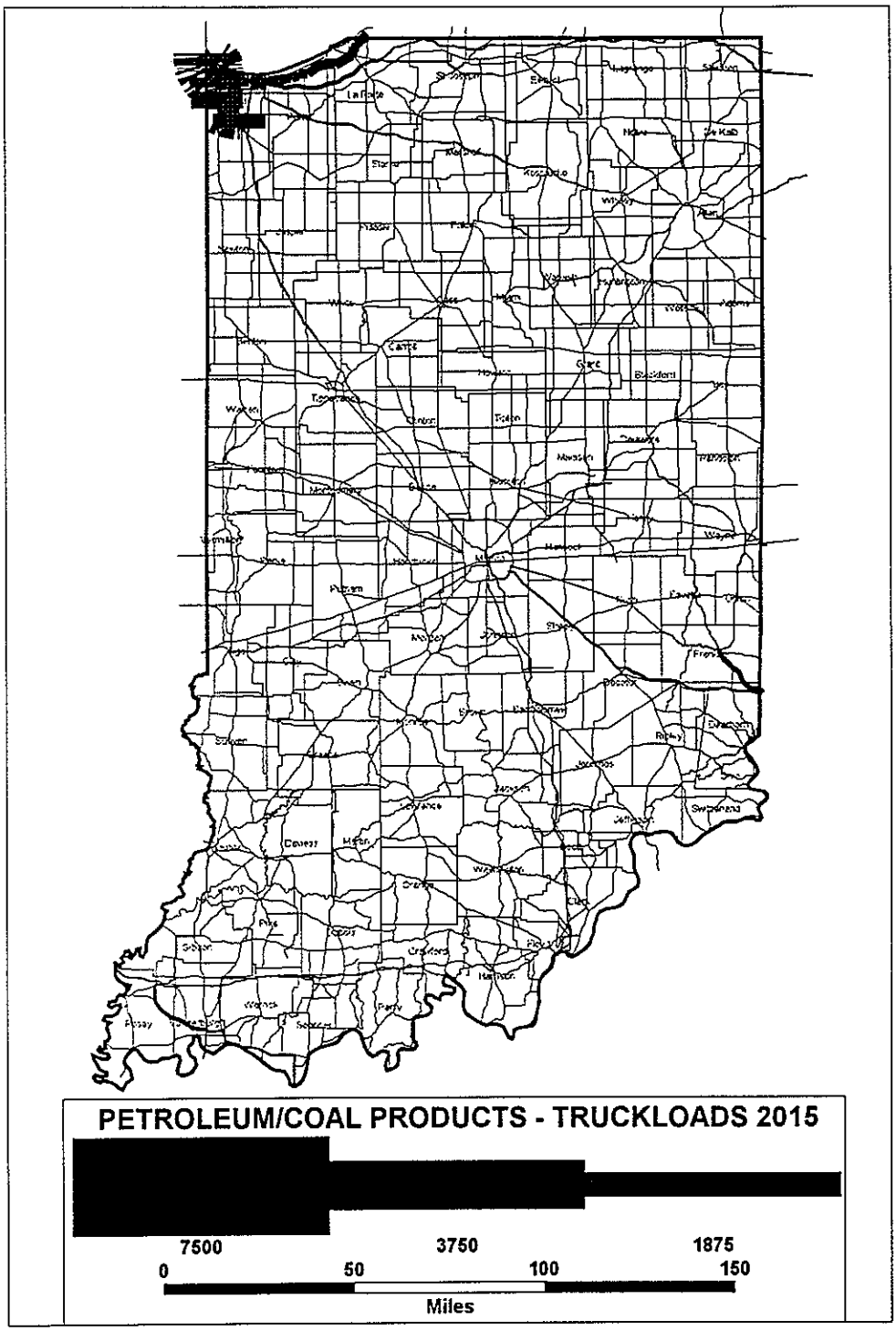

Figure 5.9 Daily Motor Carrier Volumes - Petroleum and Coal Products 2015 Forecast

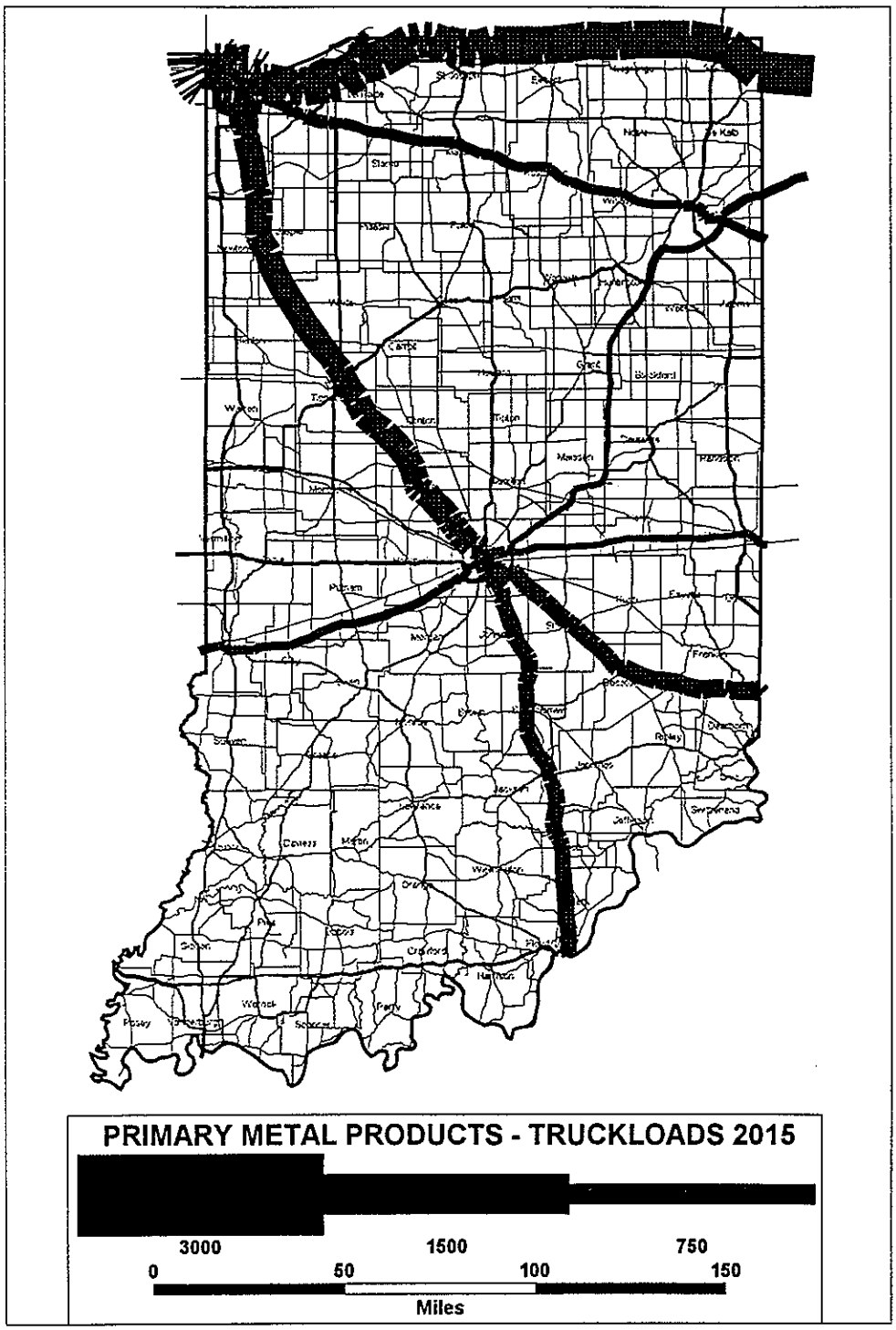

Figure 5.10 Daily Motor Carrier Volumes - Primary Metal Products 2015 Forecast

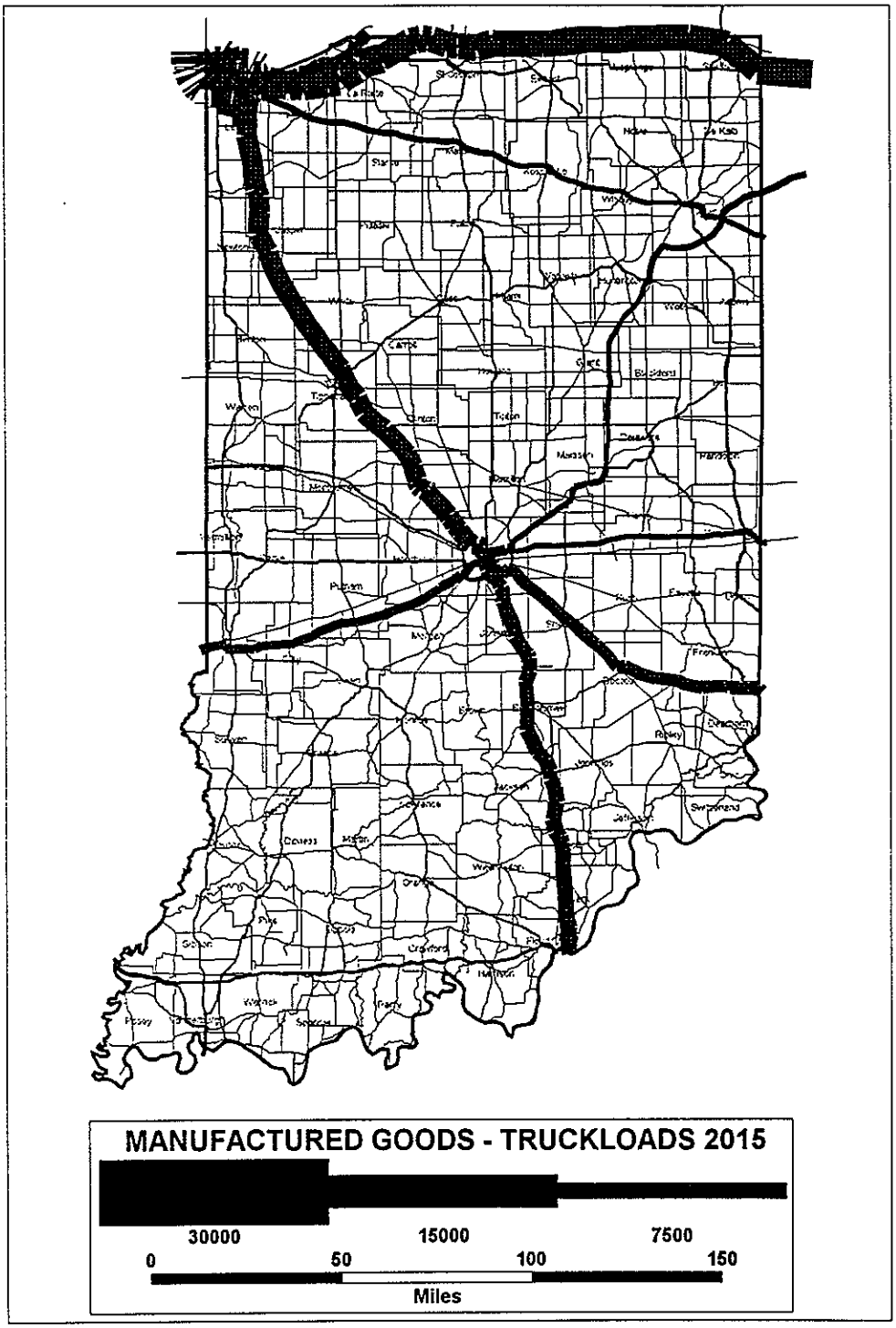

Figure 5.11 Daily Motor Carrier Volumes - Manufactured Goods 2015 Forecast

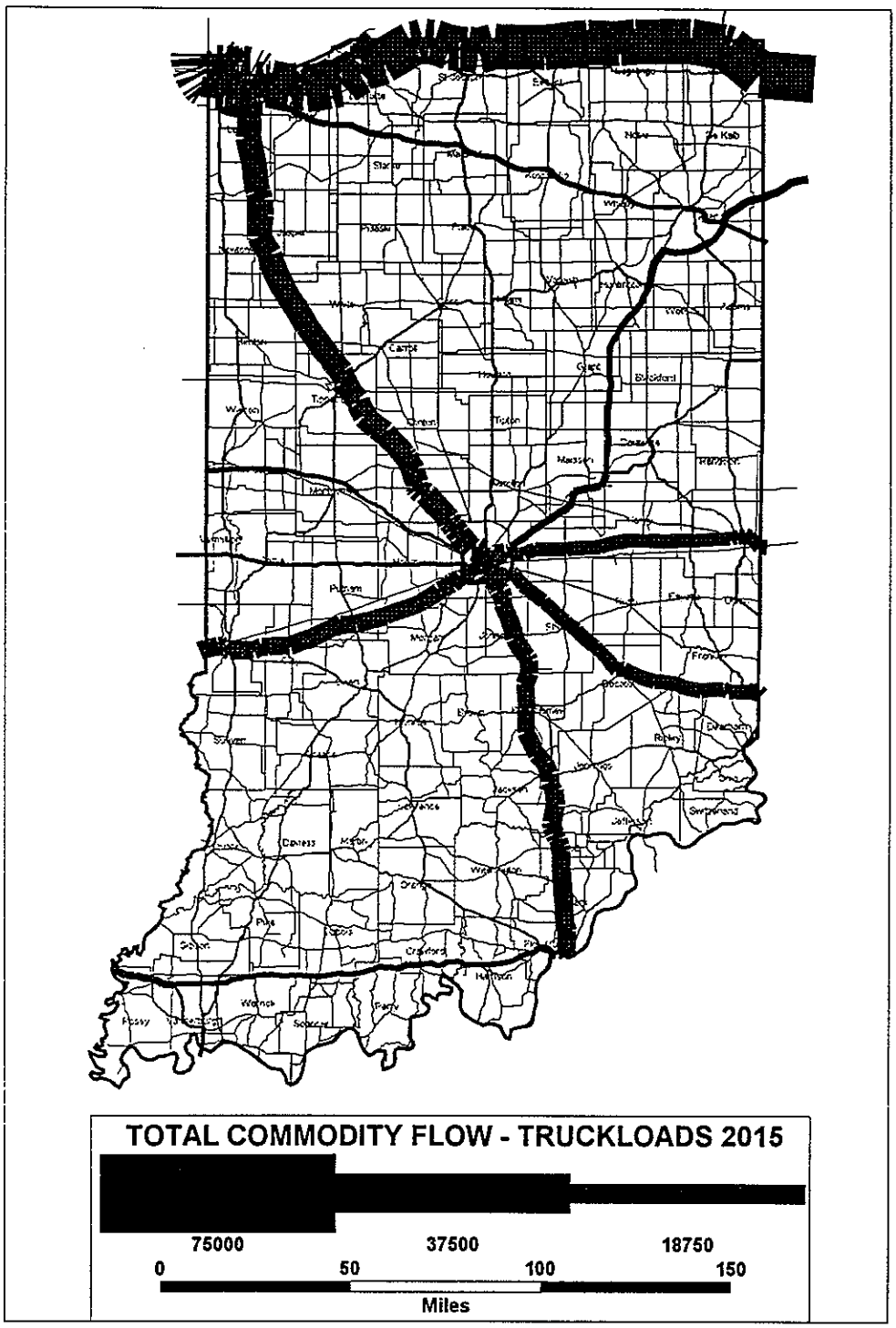

Figure 5.12 Daily Motor Carrier Volumes - Total Traffic 2015 Forecast

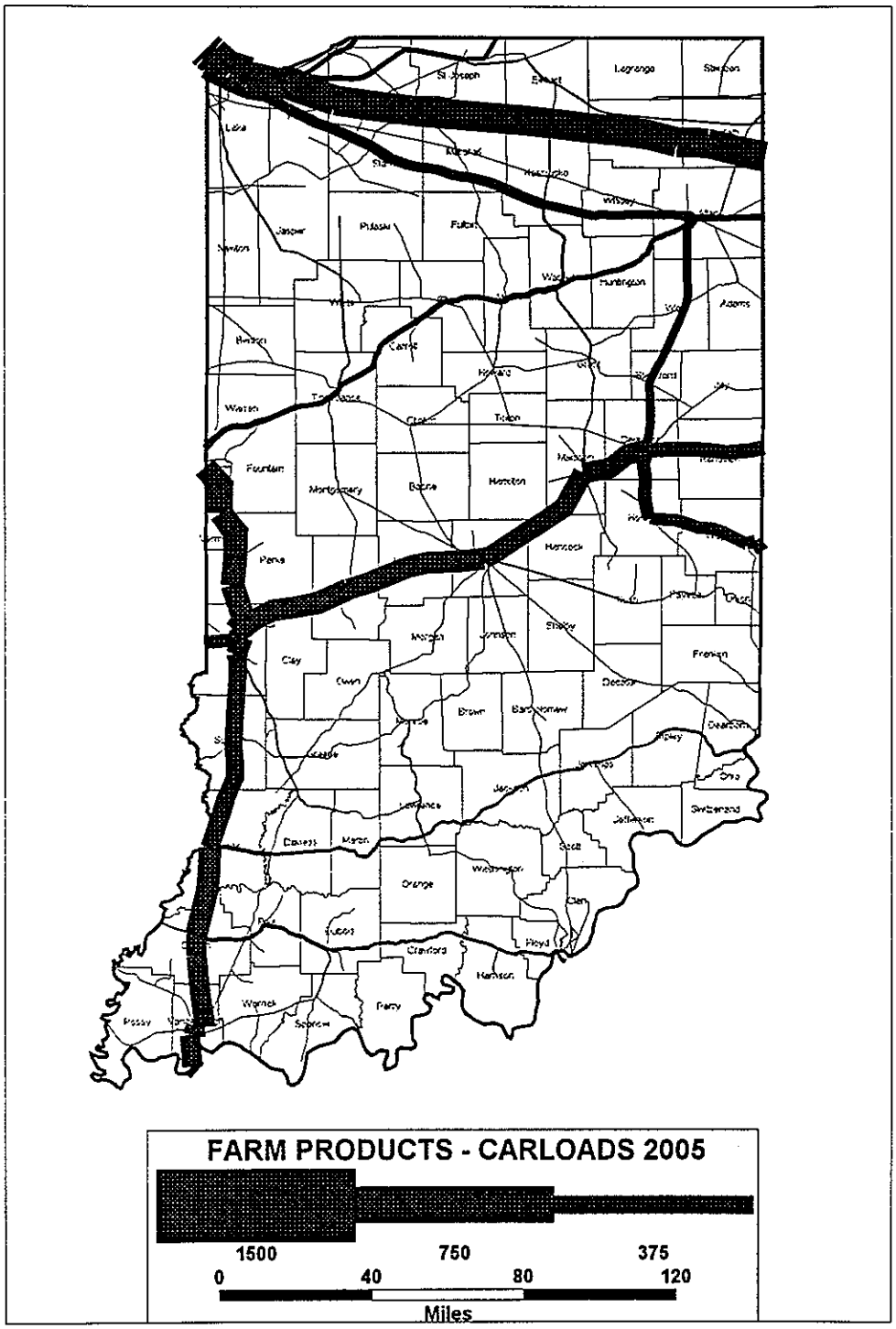

Figure 5.13 Daily Railroad Carloads - Farm Products 2005 Forecast

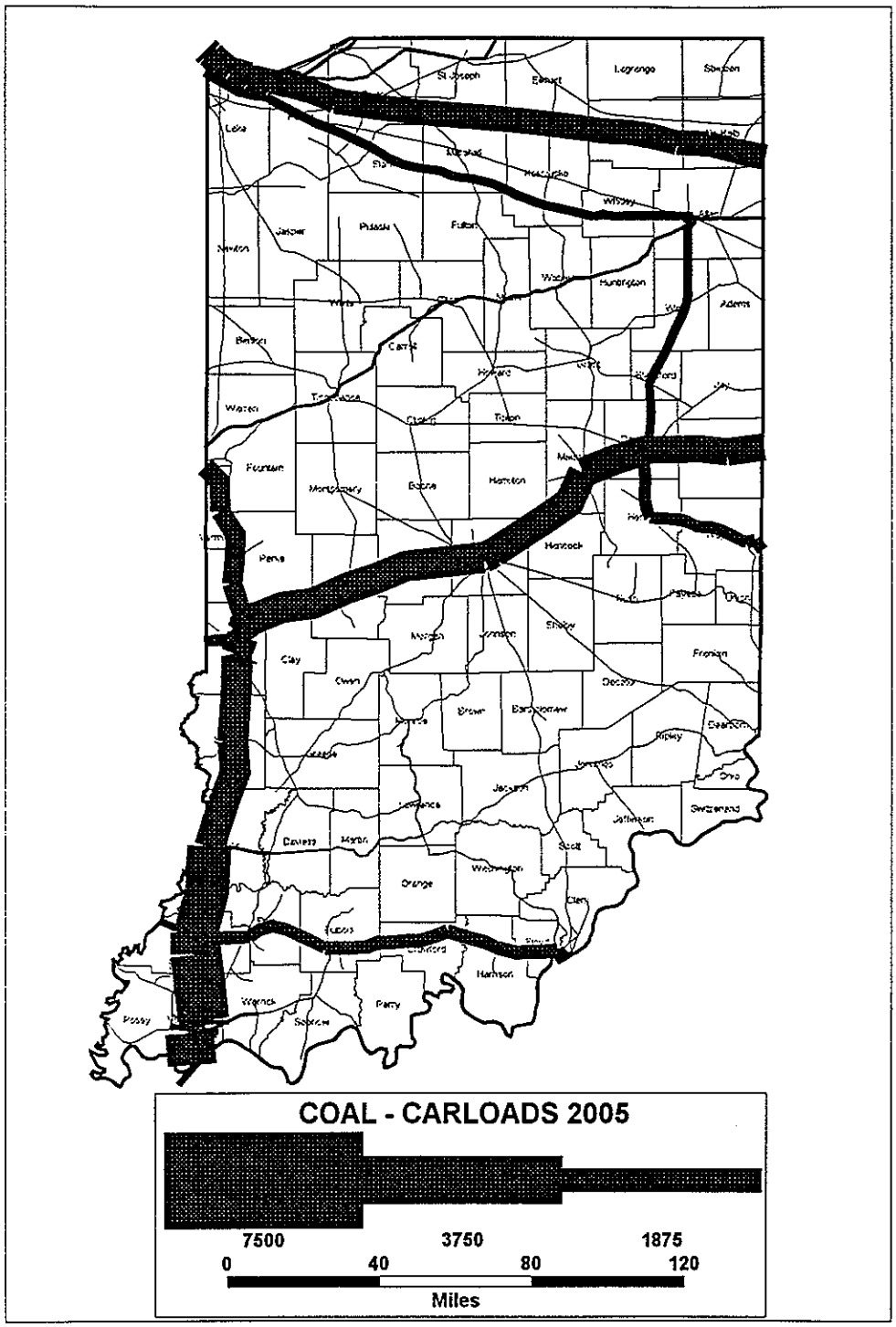

Figure 5.14 Daily Railroad Carloads - Coal 2005 Forecast

Figure 5.15 Daily Railroad Carloads - Petroleum and Coal Products 2005 Forecast

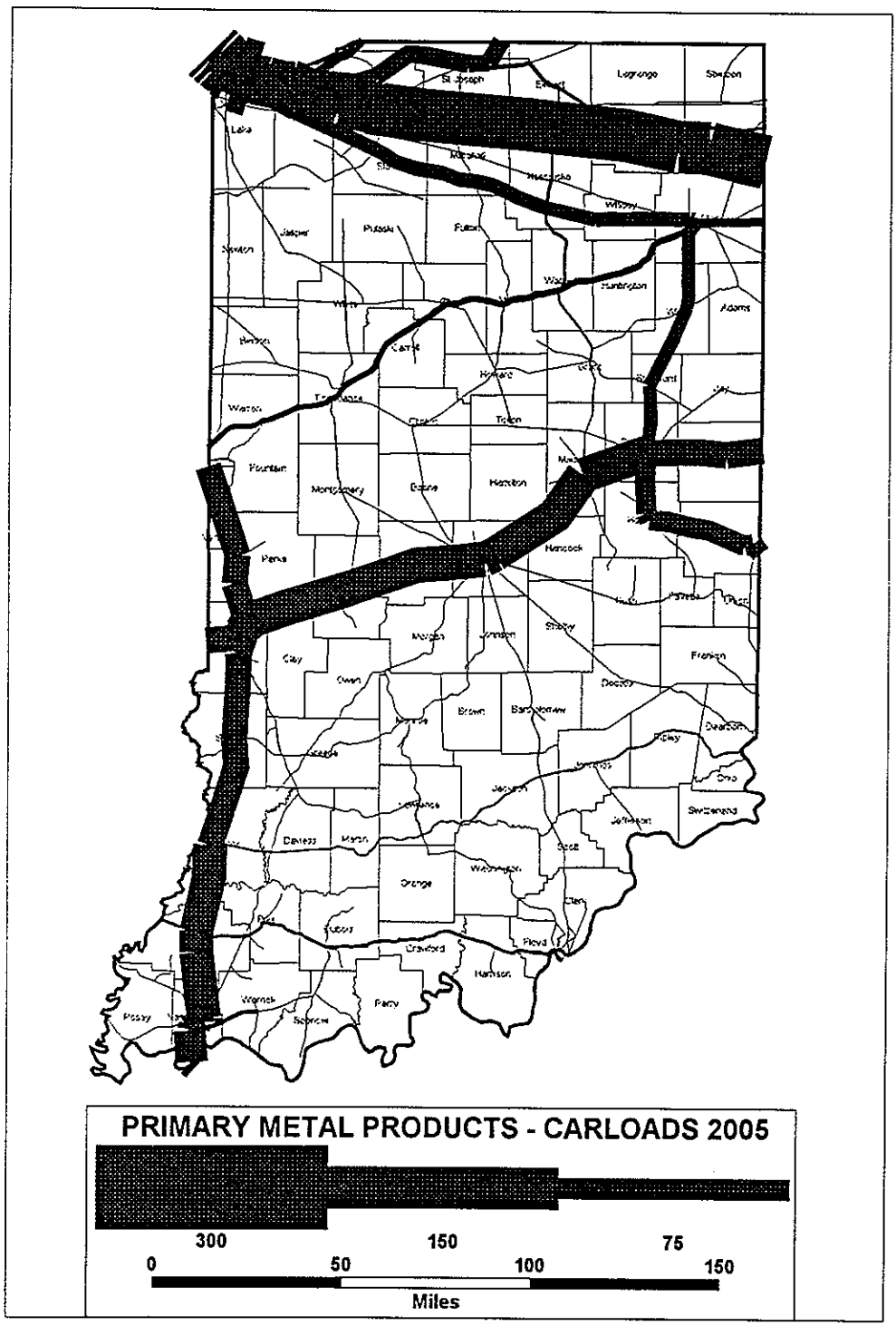

Figure 5.16 Daily Railroad Carloads - Primary Metal Products 2005 Forecast

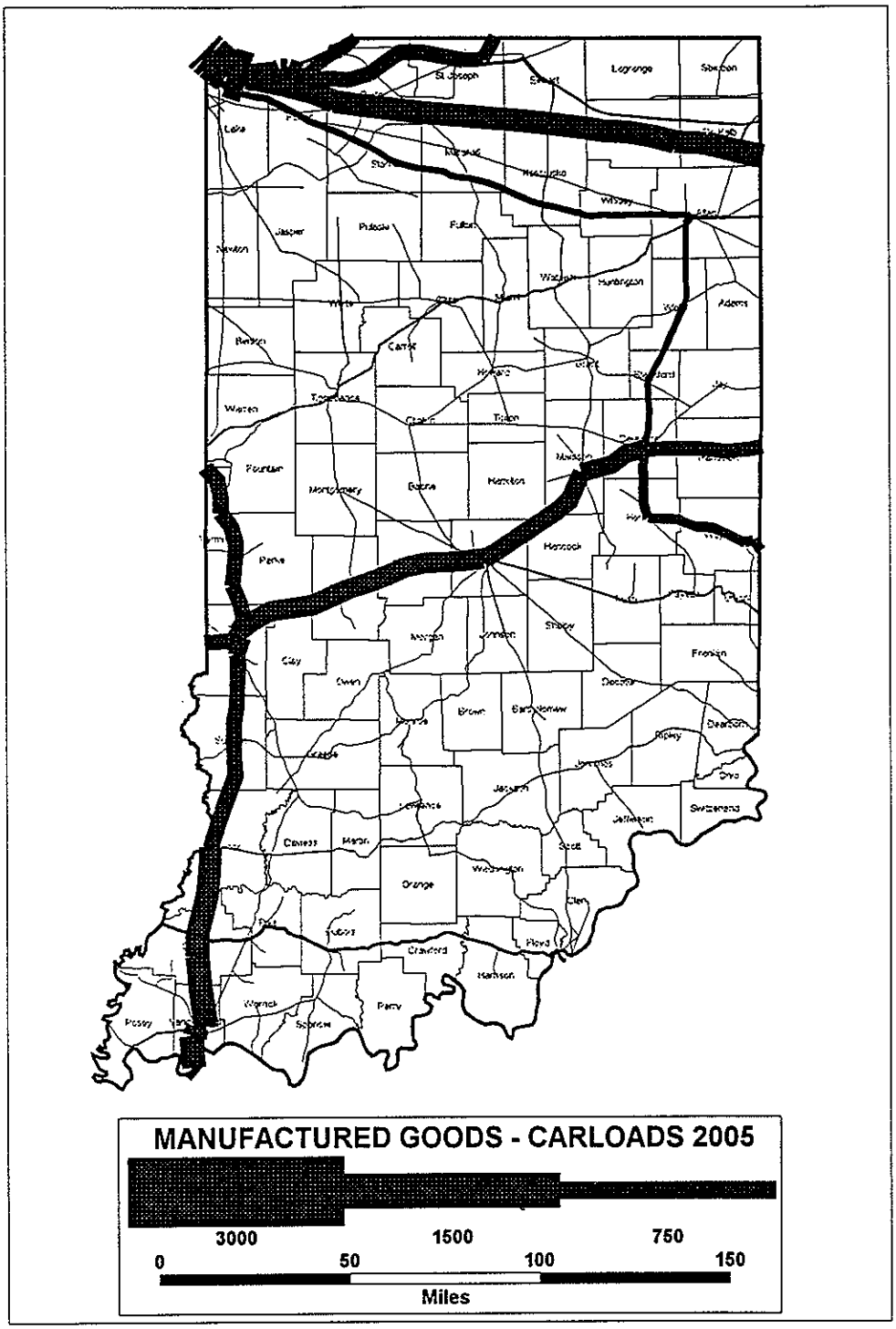

Figure 5.17 Daily Railroad Carloads - Manufactured Goods 2005 Forecast

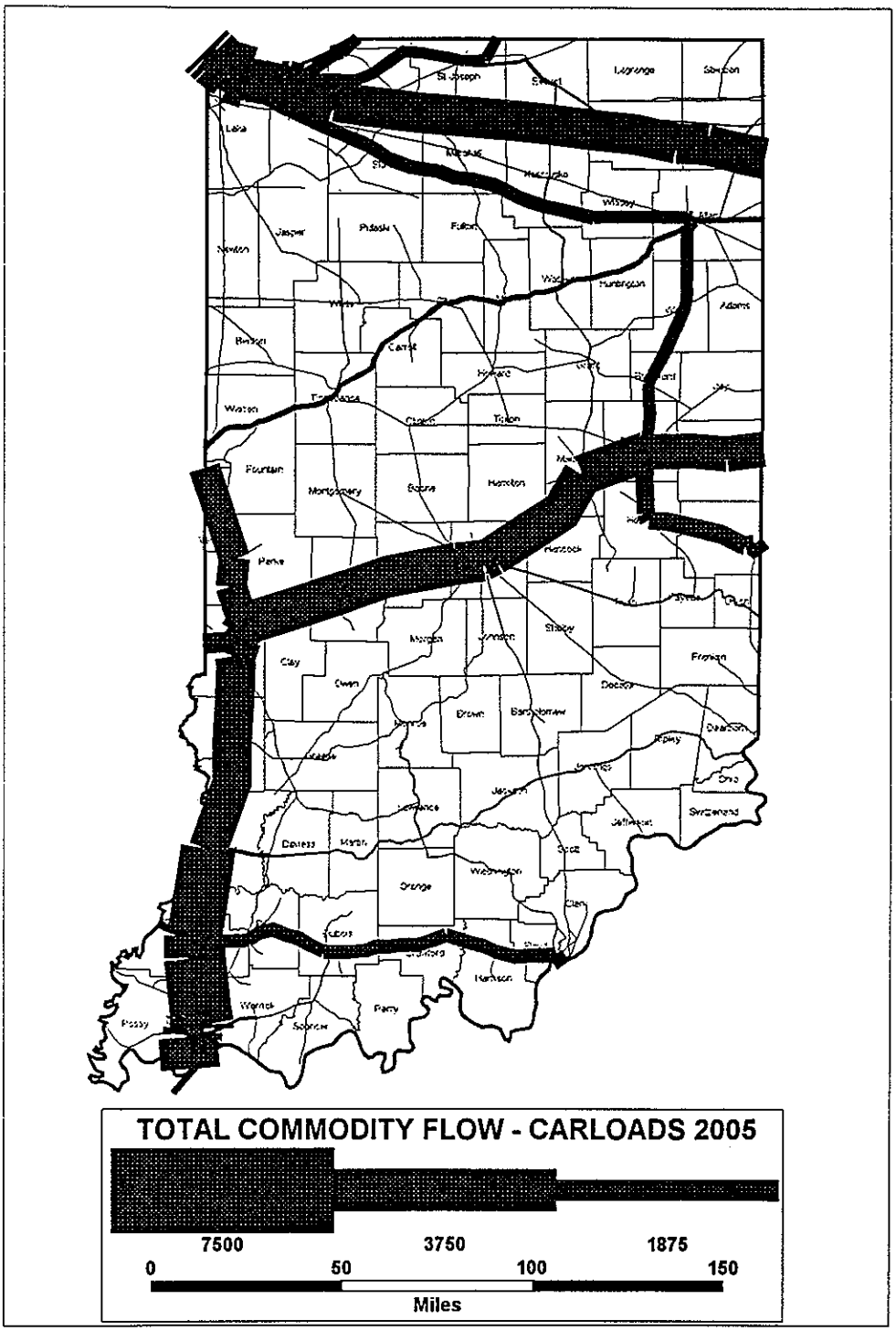

Figure 5.18 Total Daily Rail Traffic (Carloads) 2005 Forecast

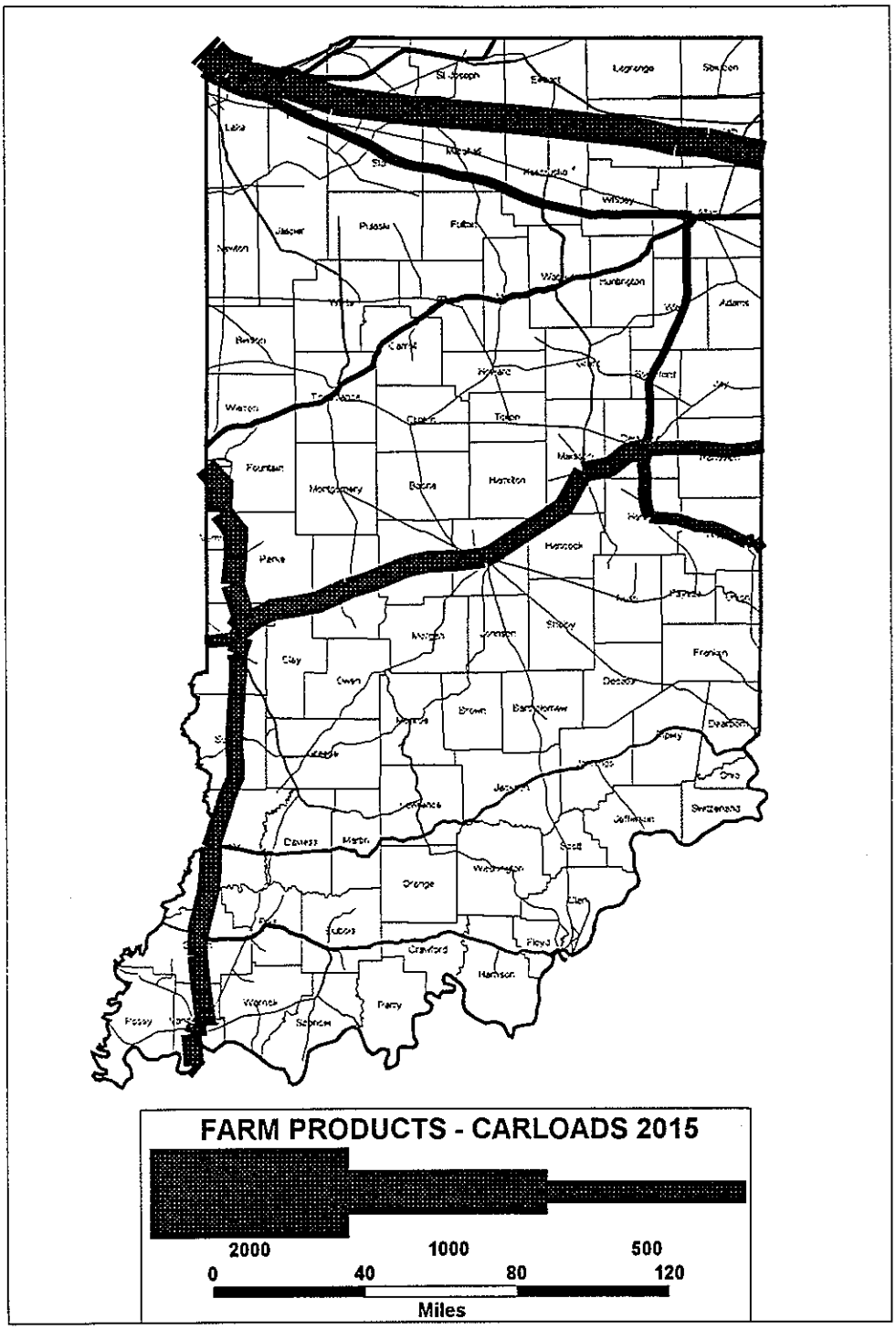

Figure 5.19 Daily Railroad Carloads - Farm Products 2015 Forecast

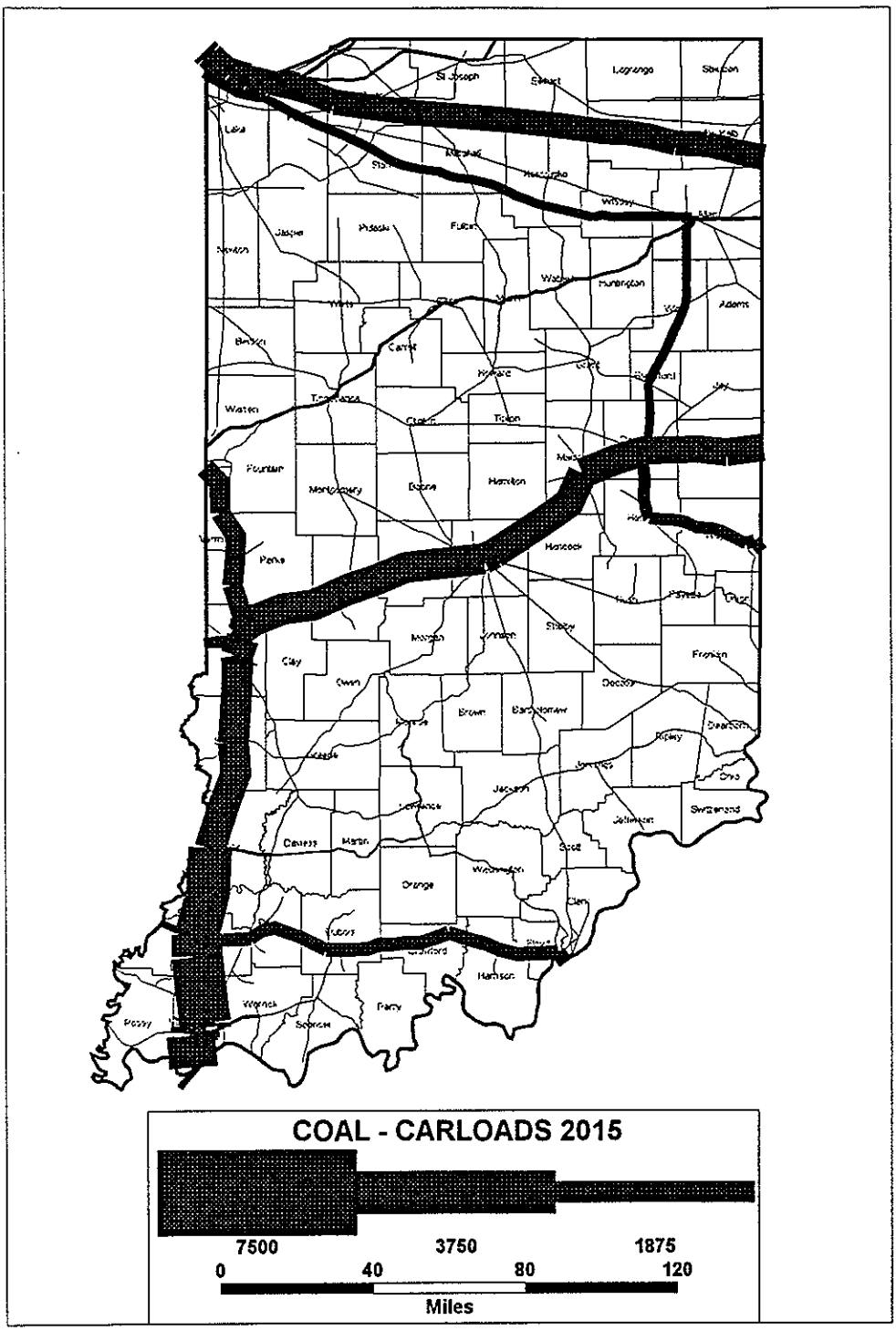

Figure 5.20 Daily Railroad Carloads - Coal 2015 Forecast

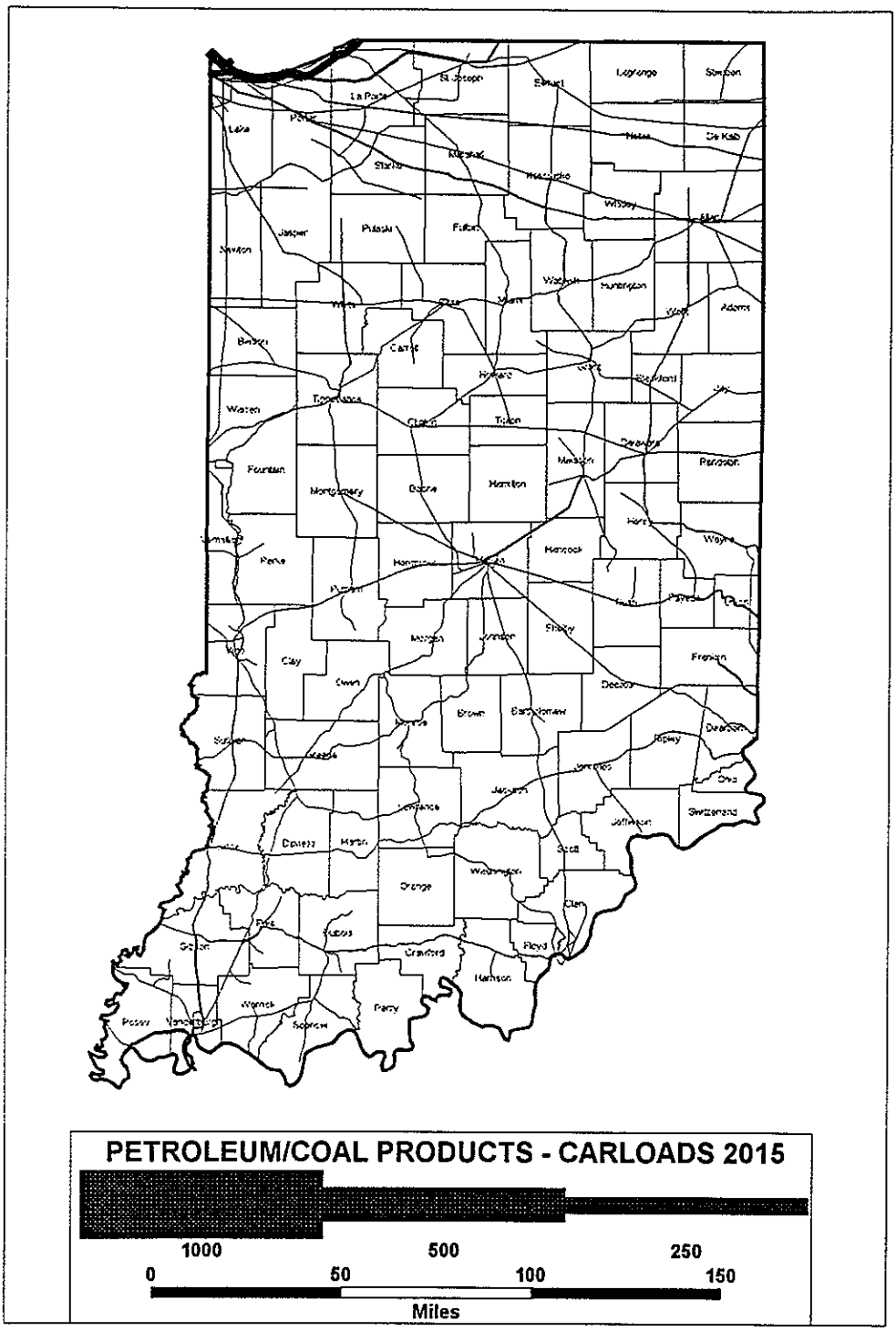

Figure 5.21 Daily Railroad Carloads - Petroleum and Coal Products 2015 Forecast

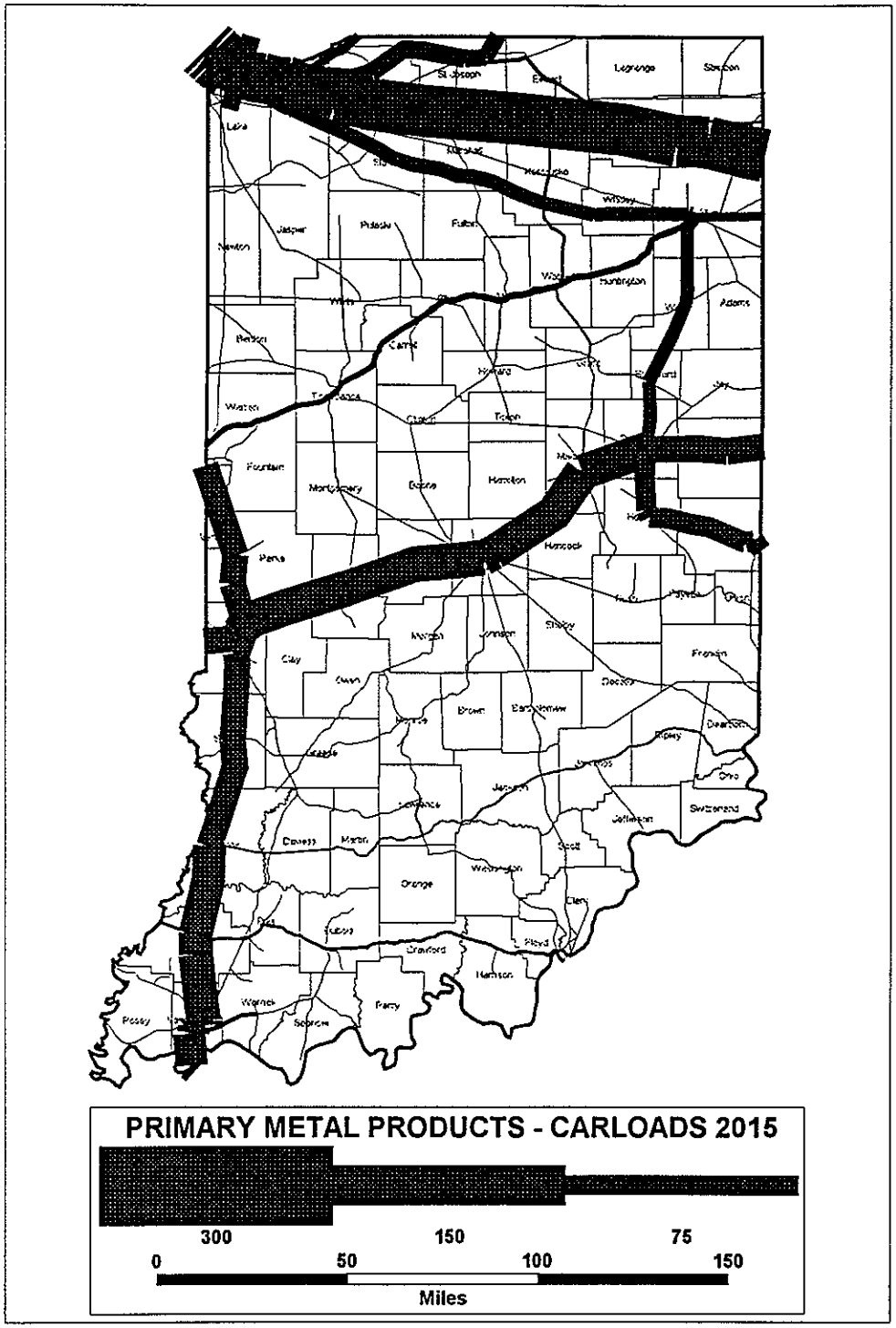

Figure 5.22 Daily Railroad Carloads - Primary Metal Products 2015 Forecast

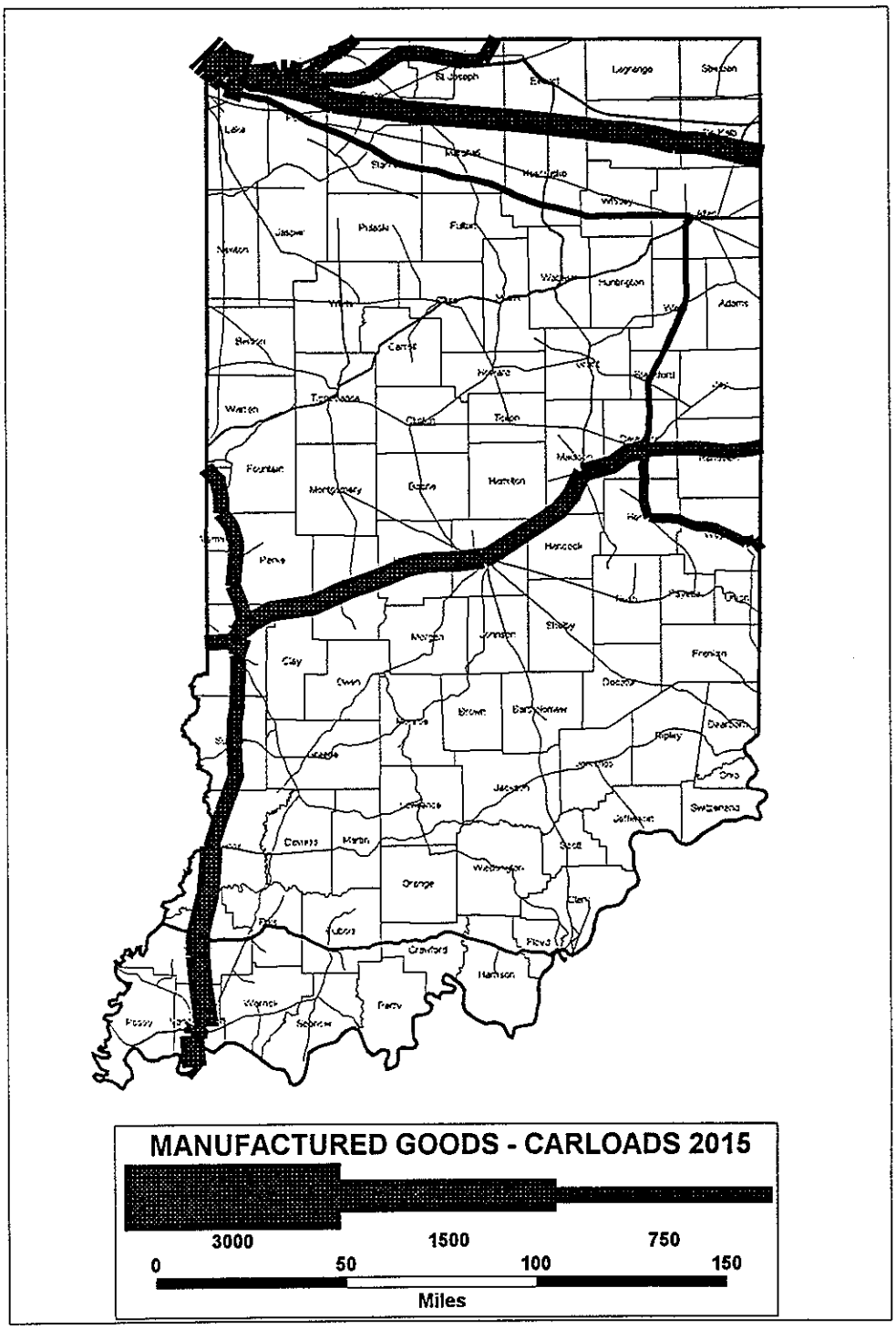

Figure 5.23 Daily Railroad Carloads - Manufactured Goods 2015 Forecast

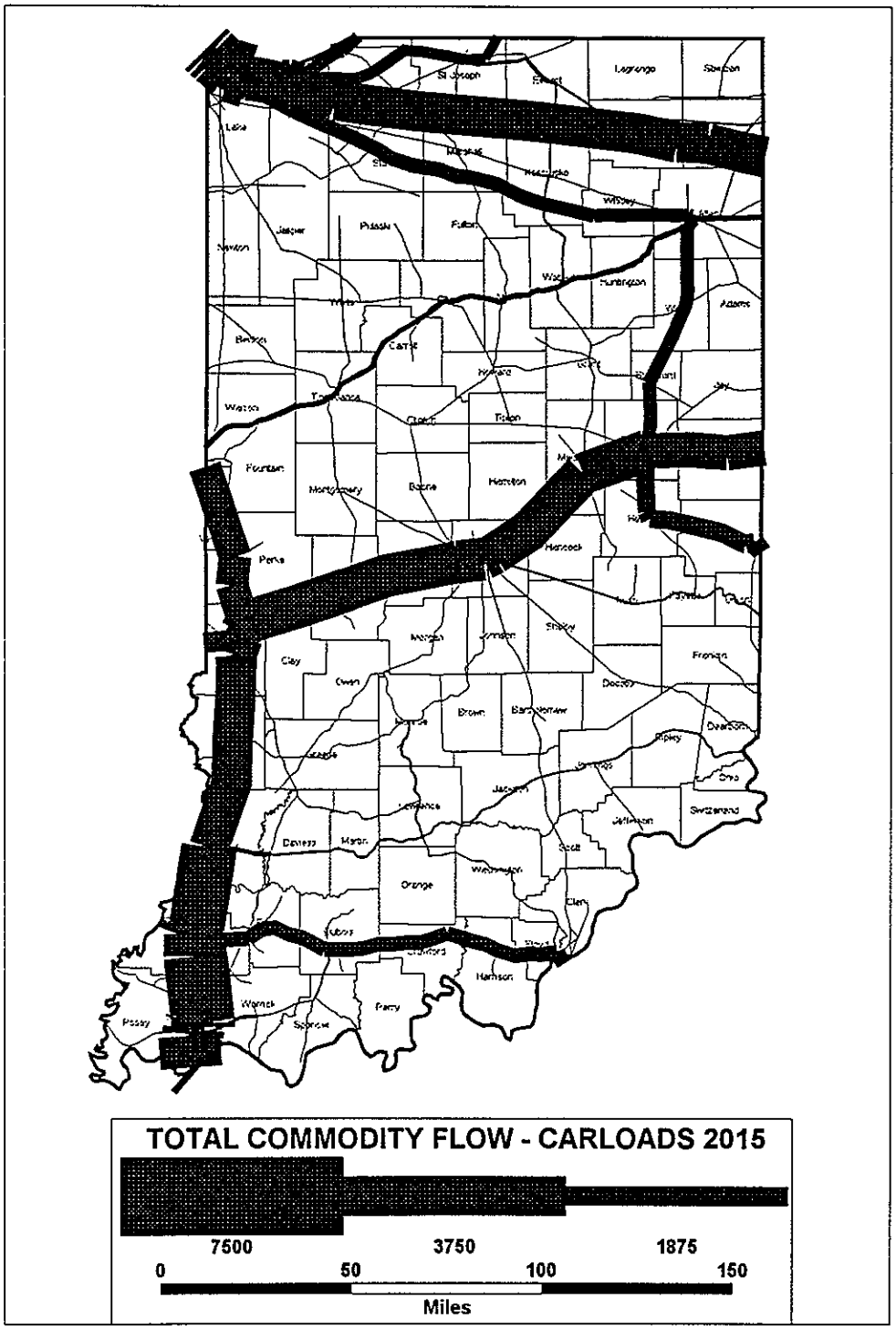

Figure 5.24 Total Daily Rail Traffic (Carloads) 2015 Forecast

Concluding Thoughts

Tables of the forecasted productions and attractions (in tons) for Indiana counties appear in an appendix of this report. Appendix D lists the existing and forecasted link and network specific flow files supplied to the State in digital form. These flows are in terms of motor carriers or rail cars. These are actually unnecessary since the State's planners can use the inputs used here, their digital network, the costing methods, and the same traffic assignment procedure used here and get the same results. In addition to vehicular forecasts of traffic to be produced and attracted, one can derive tonnage forecasts using the traffic density factors included here as multipliers on the vehicles (motor carriers or rail cars) to get tonnages. The tonnages in turn can be expanded by the value per ton figures here to obtain dollars of traffic produced or attracted by mode and commodity.

There is a temptation to evaluate the flow forecasts. It should be obvious that this is not possible until the forecast target dates have been reached (2005 or 2015) and data have been collected for those future points in time. One's acceptance of the forecasts should be influenced by the quality of the methods used in the analysis of the 1993 flows and the accuracy of the methods in replicating existing conditions. It has been demonstrated that the methods used here appear to be quite accurate.

One may question the assumptions of the modeling process undertaken here. Are the fully constrained gravity model's parameters stable into the future? Will commodity density values remain constant into the future and will the transport modes and factors that determine their use be the same in 2005 or 2015? We don't know the answers to these questions. It is believed that the analytical process followed here is about as rigorous as could have been undertaken given the resources available. It should provide answers to many of the transport policy questions the State has with regard to the flow of farm products, minerals, and manufactured commodities.

References Cited

[1] Black, William R., and Palmer, James A., (1993), *Transport Flows in the State of Indiana: Commodity Database Development and Traffic Assignment, Phase 1*, Bloomington, IN: Transportation Research Center, Indiana University, reprinted 1994.

[2] Bureau of the Census, *County Business Patterns,* Washington, DC: U.S. Department of Commerce, biannually.

[3] Bureau of the Census, *Census of Population*, Washington, DC: U.S. Department of Commerce, decennial.

[4] Woods and Poole Economics, Inc. (1992), *1992 State Profile Indiana*, Washington, DC: Woods and Poole Economics, Inc.

[5] McCarty, Harold H. and Black, William R., (1973), *A Locationally Oriented Classification of American Industries*, Bloomington, IN: Department of Geography, Indiana University, Geographic Monograph Series, Vol. 4.